JC07 Rec'd PCT/PTO 11 MAR 2002

FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER **112740-551** U S APPLICATION NO (IF KNOWN, SEE 37 CFR 10/070866
INTERNATIONAL APPLICATION NO. **PCT/DE00/03077**	INTERNATIONAL FILING DATE **06 September 2000**	PRIORITY DATE CLAIMED **09 September 1999**

TITLE OF INVENTION
MOBILE RADIO TRANSMITTING AND RECEIVING DEVICE WITH A TUNABLE ANTENNA

APPLICANT(S) FOR DO/EO/US
Alfred Deinert et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U S C 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U S C 371
3. ☒ This is an express request to begin national examination procedures (35 U S.C 371(f)) The submission must include itens (5), (6), (9) and (24) indicated below
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31)
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   - a ☒ is attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ has been communicated by the International Bureau.
   - c ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. ☒ is attached hereto.
   - b ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C 371 (c)(3))
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b ☐ have been communicated by the International Bureau.
   - c ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C 371(c)(3))
9. ☒ An oath or declaration of the inventor(s) (35 U.S C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U S C 371 (c)(5))
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409)
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1 98
14. ☒ An assignment document for recording A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter 2 and 35 U S C. 1 821 - 1.825
20. ☐ A second copy of the published international application under 35 U S.C 154(d)(4)
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

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U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR 10/070866	INTERNATIONAL APPLICATION NO PCT/DE00/03077	ATTORNEY'S DOCKET NUMBER 112740-551

24. The following fees are submitted:.

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) . **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	10 - 20 =	0	x $18.00	$0.00	
Independent claims	1 - 3 =	0	x $84.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$890.00	
☐ Applicant claims small entity status Sec 37 CFR 1.27) The fees indicated above are reduced by 1/2				$0.00	
SUBTOTAL =				$890.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$0.00	
TOTAL NATIONAL FEE =				$890.00	
Fee for recording the enclosed assignment (37 CFR 1 21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				$0.00	
TOTAL FEES ENCLOSED =				$890.00	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$890.00** to cover the above fees is enclosed

b. ☐ Please charge my Deposit Account No. ______________ in the amount of ______________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No **02-1818** A duplicate copy of this sheet is enclosed

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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SIGNATURE

William E. Vaughan
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39,056
REGISTRATION NUMBER

March 11, 2002
DATE

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BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANTS:	Alfred Deinert et al.	DOCKET NO: 112740-551
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/DE00/03077
INTERNATIONAL FILING DATE:		06 September 2000

INVENTION: MOBILE RADIO TRANSMITTING AND RECEIVING DEVICE WITH A TUNABLE ANTENNA

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

10/070866
JC13 Rec'd PCT/PTO 11 MAR 2002

SPECIFICATION

TITLE OF THE INVENTION

MOBILE RADIO TRANSMITTING AND RECEIVING DEVICE WITH A TUNABLE ANTENNA

BACKGROUND OF THE INVENTION

In radio communications systems, messages (for example, voice, picture information or other data) are transmitted via electromagnetic waves. The electromagnetic waves are transmitted via antennas, with the carrier frequencies being in the frequency band intended for the respective system.

In addition to the requirement to restrict the dimensions of the antenna for mobile radio transmitting and receiving devices, there is also an increasing requirement for the capability to transmit and receive in different frequency bands. For this reason, antennas are required which can be used in a number of frequency bands.

When using conventional antennas (for example, rod antennas as are used, in particular, in mobile parts) the required coverage of a frequency band which is as wide as possible, or of a number of frequency bands, cannot be ensured since the impedance and antenna gain of the antenna vary severely as a function of the frequency. As such, it is impossible to use the antenna in certain frequency ranges.

Thus, in order to solve this problem, antenna systems have been used which include a number of antennas, each of which covers a specific frequency range.

Antenna systems such as these have the disadvantages that they require more space and, moreover, the matching of the antennas to the individual frequencies from the respective frequency band is less than optimum.

An object to which the present invention is directed to design a mobile radio transmitting and receiving device such that, while covering a wide frequency range, it ensures a virtually constant, stable antenna gain.

SUMMARY OF THE INVENTION

Accordingly, the mobile radio transmitting and receiving device of the present invention has an electrically effective antenna body, in whose near field a dielectric body is mounted such that it can move. As such, the dielectric body can be moved in the near field of the antenna body such that the extent to which the dielectric body and the electrically effective antenna body overlap in the near field is varied. The resonant frequency which can

be set, in this case, becomes lower the greater the extent of the overlap in the near field of the antenna body. In order to make it possible to adjust the extent of the overlap, it is possible to adjust the position of the dielectric body. The position is varied on the basis of at least one control signal, which is produced as an output signal by a control device and is passed to an adjusting part of the device. The control signal is produced by the control device until the extent of the overlap ensures an optimum value of at least one physical variable, which represents a function of the transmission/reception quality of the radio transmitting and receiving device, and which is detected by a detection part and is passed as an input signal to the control device.

The major advantage of the mobile radio transmitting and received device according to the present invention is that the antenna gain is largely stable over a wide frequency range, which is achieved by regulating the variable or variables which represents or represent the reception quality as an optimum value by moving the dielectric body in the near area of the antenna body. In this case, the extent of the overlap of the antenna body and of the dielectric body leaves the polar diagram of the antenna virtually unchanged, thus ensuring good matching over the frequency range. Furthermore, the arrangement has the advantage that the antenna (the antenna body) need not be moved, which is advantageous to the design of the mobile radio transmitting and receiving device, and the external electrical influence is minimized.

A major advantage of one embodiment of the present invention is that any directional electrical influence on the antenna by the user, in particular by his/her head, on the radio transmitting and receiving device is minimized, and vice versa.

Pursuant to another embodiment of the present invention, it is possible to minimize non-directional external influences simultaneously, since they have a greater effect the greater the electrically effective antenna length of an antenna. At the same time, the connection for the radio-frequency signal is applied through the slot which runs parallel to the longitudinal axis, so that the dielectric hollow body can move without impediment and without changing the length of the supply line for the radio-frequency signal.

An advantage of yet another embodiment of the present the invention is the provision of a simple device for adjusting the position of the dielectric body, which requires only one control signal.

Another embodiment of the present invention includes the provision of a simple adjusting part for the position of the dielectric body, which require only one control signal, with the adjustment process being carried out in defined steps (step angles).

Major advantages of another embodiment of the present invention are the flexibility and updating capability for implementation of the control process, which is facilitated by the use of (control) software, and the capability to use already existing processors for controlling the mobile radio transmitting and receiving device according to the present invention by the use of additional software, or by the adaptation of existing software.

In another embodiment of the present invention, advantages are found in the simple and advantageous implementation of the control unit, and the capability to implement this switching mechanism, as an integrated circuit in an expansion module.

An advantage of yet another embodiment lies in the high dielectric constant of ceramic, since the frequency range in which the antenna can be tuned, and thus can be used, increases in proportion to the magnitude of the dielectric constant of the hollow body that is used, and the purchasing costs are low, since ceramic bodies are produced in large numbers; for example, as bodies for resonators.

An advantage of a further embodiment of the present invention is that it is possible to use the mobile radio transmitting and receiving device in a frequency range within which the ratio of the highest to lowest frequency is at least 1.5 octaves.

The detection of the forward transmission power and backward transmission power in another embodiment as a physical variable which represents a function of the transmission/reception quality of the radio transmitting and receiving device allows simple implementation of the control (matching) for the antenna, since parts which already exist in the radio transmitting and receiving device can be used for this purpose.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a mobile radio transmitting and receiving device with a rod antenna, which is enclosed by a dielectric body in the form of a slotted hollow cylinder (illustrated in section form), in which case the dielectric body can be extended and retracted via a controlled electric motor.

Figure 2 shows a mobile radio transmitting and receiving device with a rod antenna, in which a dielectric body in the form of a rod is arranged parallel to the antenna, in which case the dielectric body can be extended and retracted using a controlled electric motor.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a mobile radio transmitting and receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SA, in which case the maximum effective antenna length l_{max} for radio purposes is governed by the length of the rod antenna SA.

A dielectric body in the form of a rod SB is arranged parallel to the longitudinal axis of the rod antenna SA. The distance of the rod should not be excessively large in comparison to the wavelength, since the different phase delay times which would otherwise occur would result in a different polar diagram characteristic than that which is normal for rod antennas (monopole antennas).

Alternatively, the dielectric body may have other desired geometric shapes. The only essential feature is that, when the dielectric body is introduced into the near field of the antenna, the antenna is tuned such that it is tuned to the current frequency.

The way in which the choice of the geometric shape is made depends in, particular, on the antenna and may, for example, be determined by simulation or by trial installations.

The frequency range that is covered is increased by increasing the volume and increasing the dielectric constant of the dielectric body that is used.

Thus, the dielectric body can be manufactured, for example, from ceramic, since ceramic may have a dielectric constant of 88.

The dielectric rod SB is mounted such that it can move in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which, for example, is in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and a support wheel SR makes contact with it on the side of the rod SB opposite the point of contact (for support) so that the rotary movement of the drive wheel AR is converted to a linear movement of the rod SB, thus defining an extent M by which the rod antenna SA and the dielectric rod SB overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) μP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on an input variable EQ which is applied to the control unit μP.

The control unit μP controls the electric motor VM via the signal U_{ST} until a physical input variable EQ, which represents the reception quality of the radio transmitting and receiving device, has reached an ideal value (optimum).

In this case, the electric motor VM is first of all driven such that it always rotates the drive roller AR in a predetermined direction (default) at the start of the control process. If the evaluation shows that the input variable EQ is moving away from the ideal value, the rotation direction is changed and the electric motor VM is driven until the input variable EQ has reached the ideal value.

Alternatively, it is also possible to start the control process from a defined start point, such as with the dielectric rod SB always being in the completely extended state (that is to say, the extent of the overlap M or a length $l_{ANT,AB}$ which is covered by the rod SB is equal to the maximum electrically effective antenna link $l_{ANT,MAX}$) and, thus, to set this start point reliably, initially, at the start of the control process. This procedure is necessary, in particular, when using the mobile radio transmitting and receiving device SE over a very wide frequency range, in which the ratio of the highest frequency to the lowest frequency is at least 1.5 octaves since, otherwise, it would be possible for a situation to occur in which an electrically effective antenna length l_{ANT}, which results from the difference between the maximum electrically effective antenna length $l_{ANT,MAX}$ and the antenna length $l_{ANT,AB}$ which is covered by the dielectric rod SB, has a magnitude corresponding to three quarters of that wavelength which results from the current frequency, so that the control process is ended, since the input variable EQ likewise reaches the ideal value in this situation. Since an object of the present invention is not achieved in this situation, this value of the antenna length l_{ANT} is not desired. It is possible to prevent the process of controlling the antenna length l_{ANT} from ending on reaching this value if, for example, suitable control software is used to start the process of controlling the antenna length l_{ANT} at a minimum effective antenna length for radio purposes, which is obtained when the dielectric rod SB is fully extended, thus ensuring that the input variable EQ always guarantees optimum matching of the antenna when it reaches the ideal value.

The (possibly preprocessed) input variable EQ is passed to the control unit μP from detection part EFM for detecting physical input variables EQ which are dependent on the extent of the overlap M, and which may be transformed by the detection part EFM to a form that is required for the control unit μP.

Alternatively, the detective part EFM also detects a number of physical input variables EQ and may preprocess them, before passing them to the control unit μP, in which case the control unit μP checks, in a corresponding manner, whether a number of input variables have reached an ideal value.

Figure 2 shows a mobile radio transmitting and receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SE, in which case a maximum effective antenna length l_{max} for radio purposes is determined by the length of the rod antenna SA.

A dielectric body in the form of a hollow body is arranged symmetrically with respect to the longitudinal axis of the rod antenna SA such that the longitudinal axis of the rod antenna SA coincides with the longitudinal axis of the dielectric hollow body HK. The diameter of the hollow body HK should be chosen such that the side walls of the hollow body are not excessively far away, with respect to the wavelength, since the different phase delay times which would otherwise occur would result in a polar diagram other than the normal polar diagram for rod antennas (monopole antennas).

In order to allow a radio-frequency signal to be passed to the rod antenna SA, a slot is provided parallel to the longitudinal axis of the rod antenna SA, through which the radio-frequency connection HF is passed such that the hollow body can be extended completely without any impediment (that is, covering the entire rod antenna) and can be retracted completely without any impediment (that is, exposing the entire rod antenna).

Alternatively, the hollow body HK also can be designed without a slot, but the radio-frequency connection HF must then be routed through the lower opening of the hollow body HK, in which case the radio-frequency connection HF and, in particular, its supply line may need to be matched when the position of the dielectric hollow body HK is changed.

The dielectric hollow body HK is mounted such that it can move in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which is, for example, in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and the support wheel SR makes contact with it on the side of the hollow body HK opposite the point of contact (for support) so that the rotary movement of the drive wheel AR is converted to a linear movement of the hollow body HK, thus defining an extent M by which the hollow body HK and the rod antenna SA overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) µP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on the input variable EQ applied to the control unit µP.

The input variable EQ is determined by a detection part that is provided.

The detection part EFM may be designed such that it has a directional coupler RK, which outputs a forward transmission power and a backward transmission power from a transmission signal (this configuration of the detection part also can be used with the embodiment of the present invention described in Figure 1).

The forward transmission power is then first of all rectified by a first rectifier, and the rectified forward transmission power is then converted by a first analog/digital converter to a first digital signal. The backward transmission power is rectified by a second rectifier, and the rectified backward transmission power is then converted by a second analog/digital converter to a second digital signal.

The digital signals are applied as an input signal to the control unit µP, with the control unit µP being, for example, in the form of a (micro)processor with associated software. When the digital signals are applied, the processor µP checks whether any of the signals have reached an ideal value; i.e., no backward transmission power or minimum backward transmission power and maximum forward transmission power.

When this is the case, no control signal U_{ST} is produced, since there is no need to change the extent of the overlap.

If this is not the case, the processor µP first of all produces a first control signal U_{ST}, so that the adjusting device VM retracts the hollow body, or extends it, in particular starting from the default value. The input signals (forward and backward transmission power) which are applied to the processor, and which are changed by this process, are checked by the processor to determine whether they have reached the ideal values. If the values of the signals (forward and backward transmission power) are worse with regard to reaching the ideal values, then the rotation direction of the part VM for adjusting the position of the dielectric hollow body HK is changed. This is done, for example, by reversing the mathematical sign of the signal U_{ST}.

The signal U_{ST} is produced following the determination of the correction direction until the forward and backward transmission powers have reached their ideal values.

Alternatively, only one of the two variables (forward transmission power or backward transmission power P_R) may be used as the controlled variable for this control loop, that is to say can be detected by the detection part EFM, with the processor μP checking whether it has reached the ideal value; i.e., minimum or no backward transmission power or maximum forward transmission power.

As an alternative to the use of an additional processor μP, it also would be feasible to upgrade already existing processors via suitable control software in order to allow this control process to be carried out.

When using an additional processor μP, it also would be feasible to integrate the detection part EFM in the processor μP.

The exemplary embodiments which have been mentioned represent only some of the embodiments that are possible pursuant to the present invention. Thus, a person who is skilled in the art and is active in this field will be able to create a large number of further embodiments by advantageous modifications without departing from the character (essence) of the present invention; i.e., matching of an antenna by moving a dielectric body in the near field of the antenna. These embodiments also are, likewise, intended to be covered by the present invention as set forth in the hereafter amended claims.

ABSTRACT OF THE DISCLOSURE

A mobile radio transmitting and receiving device with a tunable antenna wherein, in order to provide a transmission/reception capability in different frequency bands, with a virtually constant, stable antenna gain, with the radio transmitting and receiving device, a dielectric body which is mounted such that it can be moved is guided by adjusting part, which are controlled by a control device, in a near area of an antenna body, such that the extent of an overlap of the two bodies in the near area of the antenna body is changed until at least one physical input variable, which represents the reception and transmission quality, reaches an optimum.

<u>In the Claims</u>:

On page 12,cancel line 1, and substitute the following left-head justified heading therefor:

CLAIMS

Please cancel claims 1-10, without prejudice, and substitute the following claims therefor:

11. A mobile radio transmitting and receiving device, comprising:

an electrically effective antenna body;

a dielectric body mounted in a near field of the electrically effective antenna body such that the dielectric body can move, and whereupon an extent to which the dielectric body and the electrically effective antenna body overlap in the near field is changed;

an adjusting part for adjusting a position of the dielectric body;

a detection part for detecting at least one physical variable which represents a function of transmission and reception quality of the radio transmitting and receiving device; and

a control device connected to the detection part for controlling the adjusting part, via at least one control signal as a function of the at least one physical variable, until the extent of the overlap ensures an optimum value for the at least one physical variable which represents a function of the transmission and reception quality of the radio transmitting and receiving device.

12. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the electrically effective antenna body is a rod antenna, the dielectric body is a hollow body with a slot which runs parallel to a longitudinal axis of the hollow body, and the dielectric body can move along a longitudinal axis of the rod antenna such that the extent of the overlap depends on a difference between a maximum electrically active antenna length of the rod antenna and a covered antenna length of the rod antenna which is enclosed by the hollow body.

13. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the electrically effective antenna body is a rod antenna, the dielectric body is a rod, and the dielectric body can move parallel to the rod antenna, on one longitudinal face of the rod antenna, such that the extent of the overlap is governed by a difference between a

maximum electrically effective antenna length of the rod antenna and an antenna length, which is covered by the rod on the longitudinal face, of the rod antenna.

14. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the adjusting part includes at least one electric motor.

15. A mobile radio transmitting and receiving device as claimed in claim 14, wherein the electric motor is a stepping motor.

16. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the control device is a processor having software which is designed to produce the at least one control signal.

17. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the control device is a switching mechanism.

18. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the dielectric body is formed from ceramic.

19. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the control device sets the extent of the overlap to a maximum value at a start of the adjustment of the extent of the overlap.

20. A mobile radio transmitting and receiving device as claimed in claim 11, wherein the detection part detects at least one of forward transmission power and backward transmission power of a transmitted signal.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Versions with Markings to Show Changes Made.**"

In addition, the present amendment cancels original claims 1-10 in favor of new claims 11-20. Claims 1-10 have been presented solely because the revisions by crossing out underlining which would have been necessary in claims 1-10 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 U.S.C. §§101, 102, 103 or 112. Indeed, the cancellation of claims 1-10 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-10.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

SPECIFICATION

TITLE OF THE INVENTION

MOBILE RADIO TRANSMITTING AND RECEIVING DEVICE WITH A TUNABLE ANTENNA

~~Mobile radio transmitting/radio receiving device with a tunable antenna~~

BACKGROUND OF THE INVENTION

~~Description~~

In radio communications systems, messages (for example, voice, picture information or other data) are transmitted ~~by means of~~ via electromagnetic waves. The electromagnetic waves are transmitted ~~by means of~~ via antennas, with the carrier frequencies being in the frequency band intended for the respective system.

In addition to the requirement to restrict the dimensions of the antenna for mobile radio ~~transmitting/radio~~ transmitting and receiving devices, there is also an increasing requirement for the capability to transmit and receive in different frequency bands. For this reason, antennas are required which can be used in a number of frequency bands.

When using conventional antennas~~,~~ (for example, rod antennas as are used, in particular, in mobile parts~~,~~) the required coverage of a frequency band which is as wide as possible, or of a number of frequency bands, cannot be ensured since the impedance and antenna gain of the antenna vary severely as a function of the frequency~~, so that~~. As such, it is impossible to use the antenna in certain frequency ranges.

Thus, in order to solve this problem, antenna systems have ~~until now~~ been used which ~~comprise~~ include a number of antennas, each of which covers a specific frequency range.

Antenna systems such as these have the disadvantages that~~, firstly,~~ they require more space and, ~~secondly~~ moreover, the matching of the antennas to the individual frequencies from the respective frequency band is less than optimum.

~~The~~ An object ~~on~~ to which the present invention is ~~based~~ directed ~~is~~ to design a mobile radio ~~transmitting/radio~~ transmitting and receiving device such that, while covering a wide frequency range, it ensures a virtually constant, stable antenna gain.

~~This object is achieved by the features of patent claim 1.~~

SUMMARY OF THE INVENTION

~~According to claim 1,~~ Accordingly, the mobile radio ~~transmitting/radio~~ transmitting and receiving device ~~according to~~ of the present invention has an electrically effective

antenna body, in whose near field a dielectric body is mounted such that it can move~~, so that~~. As such, the dielectric body can be moved in the near field of the antenna body such that the extent to which the dielectric body and the electrically effective antenna body overlap in the near field is varied. The resonant frequency which can be set, in this case, becomes lower~~,~~ the greater the extent of the overlap in the near field of the antenna body. In order to make it possible to adjust the extent of the overlap, ~~means are, furthermore, provided for adjusting~~ it is possible to adjust the position of the dielectric body. ~~These adjusting means vary the~~ The position is varied on the basis of at least one control signal, which is produced as an output signal by a control device and is passed to ~~the~~ an adjusting ~~means~~ part of the device. The control signal is produced by the control device until the extent of the overlap ensures an optimum value of at least one physical variable, which represents a function of the transmission/reception quality of the radio ~~transmitting/radio~~ transmitting and receiving device, and which is detected by a detection ~~means~~ part and is passed as an input signal to the control device.

The major advantage of the mobile radio ~~transmitting/receiving~~ transmitting and received device according to the present invention is that the antenna gain is largely stable over a wide frequency range, which is achieved by regulating the variable or variables which represents or represent the reception quality as an optimum value by moving the dielectric body in the near area of the antenna body~~, in which~~. In this case, the extent of the overlap of the antenna body and of the dielectric body leaves the polar diagram of the antenna virtually unchanged, thus ensuring good matching over the frequency range. Furthermore, the arrangement has the advantage that the antenna (the antenna body) need not be moved, which is advantageous to the design of the mobile radio ~~transmitting/radio~~ transmitting and receiving device, and the external electrical influence is minimized.

A major advantage of ~~the development as claimed in claim 2~~ one embodiment of the present invention is that any directional electrical influence on the antenna by the user, in particular by his/her head, on the radio ~~transmitting/radio~~ transmitting and receiving device is minimized, and vice versa.

~~The development as claimed in claim 3 makes it~~ Pursuant to another embodiment of the present invention, it is possible to minimize non-directional external influences simultaneously, since they have a greater effect the greater the electrically effective antenna length of an antenna~~, with, at~~. At the same time, the connection for the radio-frequency signal ~~being~~ is applied through the slot which runs parallel to the longitudinal axis, so that the

dielectric hollow body can move without impediment and without changing the length of the supply line for the radio-frequency signal.

~~One major~~ An advantage of ~~the development as claimed in claim 4~~ yet another embodiment of the present the invention is the provision of a simple device for adjusting the position of the dielectric body, which requires only one control signal.

~~A major advantage of the development as claimed in claim 5 is~~ Another embodiment of the present invention includes the provision of a simple adjusting ~~means~~ part for the position of the dielectric body, which require only one control signal, with the adjustment process being carried out in defined steps (step angles).

Major advantages of ~~the development as claimed in claim 6~~ another embodiment of the present invention are the flexibility and updating capability for implementation of the control process, which is facilitated by the use of (control) software, and the capability to use already existing processors for controlling the mobile radio ~~transmitting/radio~~ transmitting and receiving device according to the present invention by the use of additional software, or by the adaptation of existing software.

~~Major advantages of the development as claimed in claim 7 are~~ In another embodiment of the present invention, advantages are found in the simple and advantageous implementation of the control unit, and the capability to implement this switching mechanism, as an integrated circuit in an expansion module.

~~The major~~ An advantage of ~~the development as claimed in claim 8 is~~ yet another embodiment lies in the high dielectric constant of ceramic, since the frequency range in which the antenna can be tuned, and ~~can~~ thus can be used, increases in proportion to the magnitude of the dielectric constant of the hollow body that is used, and the purchasing costs are low, since ceramic bodies are produced in large numbers~~,~~; for example, as bodies for resonators.

~~The major advantage of the development as claimed in claim 9 is that this makes it~~ An advantage of a further embodiment of the present invention is that it is possible to use the mobile radio ~~transmitting/radio~~ transmitting and receiving device in a frequency range within which the ratio of the highest to ~~the~~ lowest frequency is at least 1.5 octaves.

The detection of the forward transmission power and backward transmission power ~~as claimed in claim 10~~ in another embodiment as a physical variable which represents a function of the transmission/reception quality of the radio ~~transmitting/radio~~ transmitting and receiving device allows simple implementation of the control (matching) for the antenna,

since ~~means~~ parts which already exist in the radio ~~transmitting/radio~~ transmitting and receiving device can be used for this purpose.

~~Exemplary embodiments of the invention will be explained with reference to Figures 1 and 2, in which:~~

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a mobile radio ~~transmitting/radio~~ transmitting and receiving device with a rod antenna, which is enclosed by a dielectric body in the form of a slotted hollow cylinder (illustrated in section form), in which case the dielectric body can be extended and retracted ~~by means of~~ via a controlled electric motor.

Figure 2 shows a mobile radio ~~transmitting/radio~~ transmitting and receiving device with a rod antenna, in which a dielectric body in the form of a rod is arranged parallel to the antenna, in which case the dielectric body can be extended and retracted using a controlled electric motor.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a mobile radio ~~transmitting/radio~~ transmitting and receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SA, in which case the maximum effective antenna length l_{max} for radio purposes is governed by the length of the rod antenna SA.

A dielectric body in the form of a rod SB is arranged parallel to the longitudinal axis of the rod antenna SA. The distance of the rod should not be excessively large in comparison to the wavelength, since the different phase delay times which would otherwise occur would result in a different polar diagram characteristic than that which is normal for rod antennas (monopole antennas).

Alternatively, the dielectric body may have ~~any~~ other desired geometric shapes. The only essential feature is that, when the dielectric body is introduced into the near field of the antenna, the antenna is tuned such that it is tuned to the current frequency.

The way in which the choice of the geometric shape is made depends in, particular, on the antenna and may, for example, be determined by simulation or by trial installations.

The frequency range that is covered is increased by increasing the volume and increasing the dielectric constant of the dielectric body that is used.

~~The~~ Thus, the dielectric body can ~~thus~~ be manufactured, for example, ~~be manufactured~~ from ceramic, since ceramic may have a dielectric constant of 88.

The dielectric rod SB is mounted such that it can move~~,~~ in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which, for example, is in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and a support wheel SR makes contact with it on the side of the rod SB opposite the point of contact ~~–for support–~~(for support) so that the rotary movement of the drive wheel AR is converted to a linear movement of the rod SB, thus defining an extent M by which ~~the~~ the rod antenna SA and the dielectric rod SB overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) µP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on an input variable EQ which is applied to the control unit µP.

The control unit µP controls the electric motor VM ~~by means of~~ via the signal U_{ST} until a physical input variable EQ, which represents the reception quality of the radio ~~transmitting/radio~~ transmitting and receiving device, has reached an ideal value (optimum).

In this case, the electric motor VM is first of all driven such that it always rotates the drive roller AR in a predetermined direction (default) at the start of the control process. If the evaluation shows that the input variable EQ is moving away from the ideal value, the rotation direction is changed and the electric motor VM is driven until the input variable EQ has reached the ideal value.

Alternatively, it is also possible to start the control process from a defined start point, ~~for example~~ such as with the dielectric rod SB always being in the completely extended state ~~-~~(that is to say, the extent of the overlap M or a length $l_{ANT,AB}$ which is covered by the rod SB is equal to the maximum electrically effective antenna link $l_{ANT,MAX}$~~-~~) and, thus, to set this start point reliably, initially, at the start of the control process. This procedure is necessary, in particular, when using the mobile radio ~~transmitting/radio~~ transmitting and receiving device SE over a very wide frequency range, in which the ratio of the highest frequency to the lowest frequency is at least 1.5 octaves since, otherwise, it would be possible for a situation to occur in which an electrically effective antenna length l_{ANT}, which results from

the difference between the maximum electrically effective antenna length $l_{ANT,MAX}$ and the antenna length $l_{ANT,AB}$ which is covered by the dielectric rod SB, has a magnitude corresponding to three quarters of that wavelength which results from the current frequency, so that the control process is ended, since the input variable EQ likewise reaches the ideal value in this situation. Since ~~the~~ an object of the present invention is not achieved in this situation, this value of the antenna length l_{ANT} is not desired. It is possible to prevent the process of controlling the antenna length l_{ANT} from ending on reaching this value if, for example, suitable control software is used to start the process of controlling the antenna length l_{ANT} at a minimum effective antenna length for radio purposes, which is obtained when the dielectric rod SB is fully extended, thus ensuring that the input variable EQ always guarantees optimum matching of the antenna when it reaches the ideal value.

The (possibly preprocessed) input variable EQ is passed to the control unit μP from ~~means~~ detection part EFM for detecting physical input variables EQ which are dependent on the extent of the overlap M, and which may be transformed by ~~these means~~ the detection part EFM to a form that is required for the control unit μP.

Alternatively, the ~~means~~ detective part EFM also ~~detect~~ detects a number of physical input variables EQ and may preprocess them, before passing them to the control unit μP, in which case the control unit μP checks, in a corresponding manner, whether a number of input variables have reached an ideal value.

Figure 2 shows a mobile radio ~~transmitting/radio~~ transmitting and receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SE, in which case a maximum effective antenna length l_{max} for radio purposes is determined by the length of the rod antenna SA.

A dielectric body in the form of a hollow body is arranged symmetrically with respect to the longitudinal axis of the rod antenna SA such that the longitudinal axis of the rod antenna SA coincides with the longitudinal axis of the dielectric hollow body HK. The diameter of the hollow body HK should be chosen such that the side walls of the hollow body are not excessively far away, with respect to the wavelength, since the different phase delay times which would otherwise occur would result in a polar diagram other than the normal polar diagram for rod antennas (monopole antennas).

In order to allow a radio-frequency signal to be passed to the rod antenna SA, a slot is provided parallel to the longitudinal axis of the rod antenna SA, through which the radio-frequency connection HF is passed such that the hollow body can be extended completely

without any impediment~~,~~ (that is ~~to say~~, covering the entire rod antenna~~,~~) and can be retracted completely without any impediment~~,~~ (that is ~~to say~~, exposing the entire rod antenna).

Alternatively, the hollow body HK ~~can~~ also can be designed without a slot, but the radio-frequency connection HF must then be routed through the lower opening of the hollow body HK, in which case the radio-frequency connection HF~~,~~ and, in particular, its supply line~~,~~ may need to be matched when the position of the dielectric hollow body HK is changed.

The dielectric hollow body HK is mounted such that it can move~~,~~ in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which is, for example, in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and the support wheel SR makes contact with it on the side of the hollow body HK opposite the point of contact ~~–for support–~~ (for support) so that the rotary movement of the drive wheel AR is converted to a linear movement of the hollow body HK, thus defining an extent M by which the hollow body HK and the rod antenna SA overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) μP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on the input variable EQ applied to the control unit μP.

The input variable EQ is determined by a detection ~~means~~ part that ~~are~~ is provided.

~~These~~ The detection ~~means~~ part EFM may be designed such that ~~they have~~ it has a directional coupler RK, which outputs a forward transmission power and a backward transmission power from a transmission signal (this configuration of the detection ~~means can~~ part also can be used with the embodiment of the present invention described in Figure 1).

The forward transmission power is then first of all rectified by a first rectifier, and the rectified forward transmission power is then converted by a first analog/digital converter to a first digital signal. The backward transmission power is rectified by a second rectifier, and the rectified backward transmission power is then converted by a second analog/digital converter to a second digital signal.

The digital signals are applied as an input signal to the control unit μP, with the control unit μP being, for example, in the form of a (micro)processor with associated software. When the digital signals are applied, the processor μP checks whether any of the

signals have reached an ideal value~~-~~; i.e., no backward transmission power or minimum backward transmission power and maximum forward transmission power.

When this is the case, no control signal U_{ST} is produced, since there is no need to change the extent of the overlap.

If this is not the case, the processor µP first of all produces a first control signal U_{ST}, so that the adjusting device VM retracts the hollow body, or extends it, in particular starting from the default value. The input signals ~~-~~(forward and backward transmission power~~-~~) which are applied to the processor, and which are changed by this process, are checked by the processor to determine whether they have reached the ideal values. If the values of the signals ~~-~~(forward and backward transmission power~~-~~) are worse with regard to reaching the ideal values, then the rotation direction of the ~~means~~ part VM for adjusting the position of the dielectric hollow body HK is changed. This is done, for example, by reversing the mathematical sign of the signal U_{ST}.

The signal U_{ST} is produced following the determination of the correction direction until the forward and backward transmission powers have reached their ideal values.

Alternatively, only one of the two variables ~~-~~(forward transmission power or backward transmission power P_R~~-~~) may be used as the controlled variable for this control loop, that is to say can be detected by the ~~means~~ detection part EFM, with the processor µP checking whether it has reached the ideal value~~-~~; i.e., minimum or no backward transmission power or maximum forward transmission power.

As an alternative to the use of an additional processor µP, it also would ~~also~~ be feasible to upgrade already existing processors ~~by means of~~ via suitable control software in order to allow this control process to be carried out.

When using an additional processor µP, it also would ~~also~~ be feasible to integrate the ~~means~~ detection part EFM in the processor µP.

The exemplary embodiments which have been mentioned represent only some of the embodiments that are possible ~~by means of~~ pursuant to the present invention. Thus, a person who is skilled in the art and is active in this field will be able to create a large number of further embodiments by advantageous modifications without departing from the character (essence) of the present invention~~-~~; i.e., matching of an antenna by moving a dielectric body in the near field of the antenna. These embodiments also are, likewise ~~also~~, intended to be covered by the ~~invention.~~ present invention as set forth in the hereafter amended claims.

ABSTRACT OF THE DISCLOSURE

~~Abstract~~

~~Mobile radio transmitting/radio receiving device with a tunable antenna~~

~~In~~ A mobile radio transmitting and receiving device with a tunable antenna wherein, in order to provide a transmission/reception capability in different frequency bands, with a virtually constant, stable antenna gain, with ~~a~~ the radio ~~transmitting/radio~~ transmitting and receiving device, a dielectric body which is mounted such that it can be moved is guided by adjusting ~~means~~ part, which are controlled by a control device, in a near area of an antenna body, such that the extent of an overlap of the two bodies in the near area of the antenna body is changed until at least one physical input variable, which represents the reception and transmission quality, reaches an optimum.

~~Figure 1~~

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Description

Mobile radio transmitting/radio receiving device with a tunable antenna

In radio communications systems, messages (for example voice, picture information or other data) are transmitted by means of electromagnetic waves. The electromagnetic waves are transmitted by means of antennas, with the carrier frequencies being in the frequency band intended for the respective system.

In addition to the requirement to restrict the dimensions of the antenna for mobile radio transmitting/radio receiving devices, there is also an increasing requirement for the capability to transmit and receive in different frequency bands. For this reason, antennas are required which can be used in a number of frequency bands.

When using conventional antennas, for example rod antennas as are used in particular in mobile parts, the required coverage of a frequency band which is as wide as possible, or of a number of frequency bands, cannot be ensured since the impedance and antenna gain of the antenna vary severely as a function of the frequency, so that it is impossible to use the antenna in certain frequency ranges.

Thus, in order to solve this problem, antenna systems have until now been used which comprise a number of antennas, each of which covers a specific frequency range.

Antenna systems such as these have the disadvantages that, firstly, they require more space and, secondly, the matching of the antennas to the individual frequencies from the respective frequency band is less than optimum.

The object on which the invention is based is to design a mobile radio transmitting/radio receiving device such that, while covering a wide frequency range, it ensures a virtually constant, stable antenna gain.

This object is achieved by the features of patent claim 1.

According to claim 1, the mobile radio transmitting/radio receiving device according to the invention has an electrically effective antenna body, in whose near field a dielectric body is mounted such that it can move, so that the dielectric body can be moved in the near field of the antenna body such that the extent to which the dielectric body and the electrically effective antenna body overlap in the near field is varied. The resonant frequency which can be set in this case becomes lower, the greater the extent of the overlap in the near field of the antenna body. In order to make it possible to adjust the extent of the overlap, means are, furthermore, provided for adjusting the position of the dielectric body. These adjusting means vary the position on the basis of at least one control signal, which is produced as an output signal by a control device and is passed to the adjusting means. The control signal is produced by the control device until the extent of the overlap ensures an optimum value of at least one physical variable, which represents a function of the transmission/reception quality of the radio transmitting/radio receiving device, and which is detected by detection means and is passed as an input signal to the control device.

The major advantage of the mobile radio transmitting/receiving device according to the invention is that the antenna gain is largely stable over a wide frequency range, which is achieved by regulating the variable or variables which represents

or represent the reception quality as an optimum value by moving the dielectric body in the near area of the antenna body, in which case

the extent of the overlap of the antenna body and of the dielectric body leaves the polar diagram of the antenna virtually unchanged, thus ensuring good matching over the frequency range. Furthermore, the arrangement has the advantage that the antenna (the antenna body) need not be moved, which is advantageous to the design of the mobile radio transmitting/radio receiving device, and the external electrical influence is minimized.

A major advantage of the development as claimed in claim 2 is that any directional electrical influence on the antenna by the user, in particular by his head, on the radio transmitting/radio receiving device is minimized, and vice versa.

The development as claimed in claim 3 makes it possible to minimize non-directional external influences simultaneously, since they have a greater effect the greater the electrically effective antenna length of an antenna, with, at the same time, the connection for the radio-frequency signal being applied through the slot which runs parallel to the longitudinal axis, so that the dielectric hollow body can move without impediment and without changing the length of the supply line for the radio-frequency signal.

One major advantage of the development as claimed in claim 4 is the provision of a simple device for adjusting the position of the dielectric body, which requires only one control signal.

A major advantage of the development as claimed in claim 5 is the provision of simple adjusting means for the position of the dielectric body, which require only one control signal, with the adjustment process being carried out in defined steps (step angles).

Major advantages of the development as claimed in claim 6 are the flexibility and updating capability for implementation of the control process, which is facilitated by the use of (control)

software, and the capability to use already existing processors for controlling the mobile radio transmitting/radio receiving device according to the invention by the use of additional software, or by the adaptation of existing software.

Major advantages of the development as claimed in claim 7 are the simple and advantageous implementation of the control unit, and the capability to implement this switching mechanism as an integrated circuit in an expansion module.

The major advantage of the development as claimed in claim 8 is the high dielectric constant of ceramic, since the frequency range in which the antenna can be tuned, and can thus be used, increases in proportion to the magnitude of the dielectric constant of the hollow body that is used, and the purchasing costs are low, since ceramic bodies are produced in large numbers, for example as bodies for resonators.

The major advantage of the development as claimed in claim 9 is that this makes it possible to use the mobile radio transmitting/radio receiving device in a frequency range within which the ratio of the highest to the lowest frequency is at least 1.5 octaves.

The detection of the forward transmission power and backward transmission power as claimed in claim 10 as a physical variable which represents a function of the transmission/reception quality of the radio transmitting/radio receiving device allows simple implementation of the control (matching) for the antenna, since means which already exist in the radio transmitting/radio receiving device can be used for this purpose.

Exemplary embodiments of the invention will be explained with reference to Figures 1 and 2, in which:

Figure 1 shows a mobile radio transmitting/radio receiving device with a rod antenna, which is enclosed by a dielectric body in the form of a slotted hollow cylinder (illustrated in section form), in which case the dielectric body can be extended and retracted by means of a controlled electric motor.

Figure 2 shows a mobile radio transmitting/radio receiving device with a rod antenna, in which a dielectric body in the form of a rod is arranged parallel to the antenna, in which case the dielectric body can be extended and retracted using a controlled electric motor.

Figure 1 shows a mobile radio transmitting/radio receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SA, in which case the maximum effective antenna length l_{max} for radio purposes is governed by the length of the rod antenna SA.

A dielectric body in the form of a rod SB is arranged parallel to the longitudinal axis of the rod antenna SA. The distance of the rod should not be excessively large in comparison to the wavelength, since the different phase delay times which would otherwise occur would result in a different polar diagram characteristic than that which is normal for rod antennas (monopole antennas).

Alternatively, the dielectric body may have any other desired geometric shapes. The only essential feature is that, when the dielectric body is introduced into the near field of the antenna, the antenna is tuned such that it is tuned to the current frequency.

The way in which the choice of the geometric shape is made depends in particular on the antenna and may, for

example, be determined by simulation or by trial installations.

The frequency range that is covered is increased by increasing the volume and increasing the dielectric constant of the dielectric body that is used.

The dielectric body can thus, for example, be manufactured from ceramic, since ceramic may have a dielectric constant of 88.

The dielectric rod SB is mounted such that it can move, in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which, for example, is in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and a support wheel SR makes contact with it on the side of the rod SB opposite the point of contact - for support - so that the rotary movement of the drive wheel AR is converted to a linear movement of the rod SB, thus defining an extent M by which the the rod antenna SA and the dielectric rod SB overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) μP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on an input variable EQ which is applied to the control unit μP.

The control unit μP controls the electric motor VM by means of the signal U_{ST} until a physical input variable EQ, which represents the reception quality of the radio transmitting/radio receiving device, has reached an ideal value (optimum).

In this case, the electric motor VM is first of all driven such that it always rotates the drive roller AR in a predetermined direction (default)

at the start of the control process. If the evaluation shows that the input variable EQ is moving away from the ideal value, the rotation direction is changed and the electric motor VM is driven until the input variable EQ has reached the ideal value.

Alternatively, it is also possible to start the control process from a defined start point, for example with the dielectric rod SB always being in the completely extended state - that is to say the extent of the overlap M or a length $l_{ANT,AB}$ which is covered by the rod SB is equal to the maximum electrically effective antenna link $l_{ANT,MAX}$ - and thus to set this start point reliably, initially, at the start of the control process. This procedure is necessary in particular when using the mobile radio transmitting/radio receiving device SE over a very wide frequency range, in which the ratio of the highest frequency to the lowest frequency is at least 1.5 octaves since, otherwise, it would be possible for a situation to occur in which an electrically effective antenna length l_{ANT}, which results from the difference between the maximum electrically effective antenna length $l_{ANT,MAX}$ and the antenna length $l_{ANT,AB}$ which is covered by the dielectric rod SB, has a magnitude corresponding to three quarters of that wavelength which results from the current frequency, so that the control process is ended, since the input variable EQ likewise reaches the ideal value in this situation. Since the object of the invention is not achieved in this situation, this value of the antenna length l_{ANT} is not desired. It is possible to prevent the process of controlling the antenna length l_{ANT} from ending on reaching this value if, for example, suitable control software is used to start the process of controlling the antenna length l_{ANT} at a minimum effective antenna length for radio purposes, which is obtained when the dielectric rod SB is fully extended, thus ensuring that the input variable EQ always

guarantees optimum matching of the antenna when it reaches the ideal value.

The (possibly preprocessed) input variable EQ is passed to the control unit μP from means EFM for detecting physical input variables EQ which are dependent on the extent of the overlap M, and which may be transformed by these means to a form that is required for the control unit μP.

Alternatively, the means EFM also detect a number of physical input variables EQ and may preprocess them, before passing them to the control unit μP, in which case the control unit μP checks, in a corresponding manner, whether a number of input variables have reached an ideal value.

Figure 2 shows a mobile radio transmitting/radio receiving device SE with a transmitting/receiving antenna in the form of a rod antenna SE, in which case a maximum effective antenna length l_{max} for radio purposes is determined by the length of the rod antenna SA.

A dielectric body in the form of a hollow body is arranged symmetrically with respect to the longitudinal axis of the rod antenna SA such that the longitudinal axis of the rod antenna SA coincides with the longitudinal axis of the dielectric hollow body HK. The diameter of the hollow body HK should be chosen such that the side walls of the hollow body are not excessively far away, with respect to the wavelength, since the different phase delay times which would otherwise occur would result in a polar diagram other than the normal polar diagram for rod antennas (monopole antennas).

In order to allow a radio-frequency signal to be passed to the rod antenna SA, a slot is provided parallel to the longitudinal axis of the rod antenna SA, through which the radio-frequency connection HF is passed such that the hollow body can be extended completely without

any impediment, that is to say covering the entire rod antenna, and can be retracted completely without any impediment, that is to say exposing the entire rod antenna.

Alternatively, the hollow body HK can also be designed without a slot, but the radio-frequency connection HF must then be routed through the lower opening of the hollow body HK, in which case the radio-frequency connection HF, and in particular its supply line, may need to be matched when the position of the dielectric hollow body HK is changed.

The dielectric hollow body HK is mounted such that it can move, in such a way that it can be extended and retracted by a drive wheel AR which is rotated forward or backward by an electric motor VM which is, for example, in the form of a stepping motor. In this case, the drive roller AR makes contact with it on one side, and the support wheel SR makes contact with it on the side of the hollow body HK opposite the point of contact - for support - so that the rotary movement of the drive wheel AR is converted to a linear movement of the hollow body HK, thus defining an extent M by which the hollow body HK and the rod antenna SA overlap.

The (stepping) angle and the rotation direction are governed by the magnitude, the mathematical sign and/or the duration of a voltage (control signal) U_{ST} which is applied to the electric motor VM.

This voltage U_{ST} is a signal (control signal) which is produced at the output of a control unit (microprocessor) μP, and whose magnitude, mathematical sign and/or signal duration are/is dependent on the input variable EQ applied to the control unit μP.

The input variable EQ is determined by detection means that are provided.

These detection means EFM may be designed such that they have a directional coupler RK, which outputs a forward transmission power and a backward transmission power from a transmission signal (this configuration of

the detection means can also be used with the embodiment of the invention described in Figure 1).

The forward transmission power is then first of all rectified by a first rectifier, and the rectified forward transmission power is then converted by a first analog/digital converter to a first digital signal. The backward transmission power is rectified by a second rectifier, and the rectified backward transmission power is then converted by a second analog/digital converter to a second digital signal.

The digital signals are applied as an input signal to the control unit μP, with the control unit μP being, for example, in the form of a (micro)processor with associated software. When the digital signals are applied, the processor μP checks whether any of the signals have reached an ideal value - no backward transmission power or minimum backward transmission power and maximum forward transmission power.

When this is the case, no control signal U_{ST} is produced, since there is no need to change the extent of the overlap.

If this is not the case, the processor μP first of all produces a first control signal U_{ST}, so that the adjusting device VM retracts the hollow body, or extends it, in particular starting from the default value. The input signals - forward and backward transmission power - which are applied to the processor, and which are changed by this process, are checked by the processor to determine whether they have reached the ideal values. If the values of the signals - forward and backward transmission power - are worse with regard to reaching the ideal values, then the rotation direction of the means VM for adjusting the position of the dielectric hollow body HK is changed. This is done, for example, by reversing the mathematical sign of the signal U_{ST}.

The signal U_{ST} is produced following the determination of the correction direction until the forward and backward transmission powers have reached their ideal values.

Alternatively, only one of the two variables - forward transmission power or backward transmission power P_R - may be used as the controlled variable for this control loop, that is to say can be detected by the means EFM, with the processor μP checking whether it has reached the ideal value - minimum or no backward transmission power or maximum forward transmission power.

As an alternative to the use of an additional processor μP, it would also be feasible to upgrade already existing processors by means of suitable control software in order to allow this control process to be carried out.

When using an additional processor μP, it would also be feasible to integrate the means EFM in the processor μP.

The exemplary embodiments which have been mentioned represent only some of the embodiments that are possible by means of the invention. Thus, a person who is skilled in the art and is active in this field will be able to create a large number of further embodiments by advantageous modifications without departing from the character (essence) of the invention - matching of an antenna by moving a dielectric body in the near field of the antenna. These embodiments are likewise also intended to be covered by the invention.

Patent claims

1. A mobile radio transmitting/radio receiving device (SE) having the following features:

a) an electrically effective antenna body, in whose near field a dielectric body is mounted such that it can move,

b) the dielectric body can be moved in the near field of the antenna body such that the extent (M) to which the dielectric body and the electrically effective antenna body overlap in the near field is changed,

c) means (VM) for adjusting the position of the dielectric body,

d) means (EFM) for detecting at least one physical variable (EQ) which represents a function of the transmission/reception quality of the radio transmitting/radio receiving device (SE),

e) a control device (μP) which is connected to the detection means (EFM) and controls the adjusting means (VM) by means of at least one control signal (U_{ST}) as a function of the input variable (EQ) or of the input variables (EQ), until the extent of the overlap (M) ensures an optimum value for the physical variable (EQ) which represents a function of the transmission/reception quality of the radio transmitting/radio receiving device (SE).

2. The mobile radio transmitting/receiving device (SE) as claimed in claim 1,

characterized in that

a) the electrically effective antenna body is in the form of a rod antenna (SA),

b) the dielectric body is in the form of a hollow body (HK) with a slot which runs parallel to the longitudinal axis of the hollow body,

c) the dielectric body can move along the longitudinal axis of the rod antenna (SA) such

that the extent of the overlap (M) depends on the difference between the maximum electrically

active antenna length ($l_{ANT,MAX}$) of the rod antenna (SA) and a covered antenna length (l_{AB}) of the rod antenna (SA) which is enclosed by the hollow body (HK).

3. The mobile radio transmitting/receiving apparatus (SE) as claimed in claim 1,
characterized in that

a) the electrically effective antenna body is in the form of a rod antenna (SA),
b) the dielectric body is in the form of a rod (SB), and
c) the dielectric body can move parallel to the rod antenna (SA), on one longitudinal face of the rod antenna (SA), such that the extent of the overlap (M) is governed by the difference between the maximum electrically effective antenna length ($l_{ANT,MAX}$) of the rod antenna (SA) and an antenna length (l_{AB}), which is covered by the rod (SB) on the longitudinal face, of the rod antenna (SA).

4. The mobile radio transmitting/receiving device (SE) as claimed in one of the preceding claims,
characterized in that
the adjusting means (VM) is at least one electric motor.

5. The mobile radio transmitting/radio receiving device (SE) as claimed in claim 4,
characterized in that
the electric motor is a stepping motor.

6. The mobile radio transmitting/radio receiving device (SE) as claimed in one of the preceding claims,
characterized in that
the control device (μP) is a processor having software which is designed to produce the control signal (U_{ST}) or the control signals (U_{ST}).

7. The mobile radio transmitting/radio receiving device (SE) as claimed in one of claims 1 to 5, characterized in that the control device (μP) is in the form of a switching mechanism.

8. The mobile radio transmitting/radio receiving device (SE) as claimed in one of the preceding claims, characterized in that the dielectric body (DK) is formed from ceramic.

9. The mobile radio transmitting/radio receiving device (SE) as claimed in one of the preceding claims, characterized in that the control device (μP) is designed such that it sets the extent of the overlap (M) to a maximum value at the start of the adjustment of the extent of the overlap (M).

10. The mobile radio transmitting/radio receiving device (SE) as claimed one of the preceding claims, characterized in that the detection means (EFM) are designed such that they detect the forward transmission power and/or backward transmission power of a transmitted signal.

GR 99 P 2782

Abstract

Mobile radio transmitting/radio receiving device with a tunable antenna

In order to provide a transmission/reception capability in different frequency bands, with a virtually constant, stable antenna gain, with a radio transmitting/radio receiving device, a dielectric body which is mounted such that it can be moved is guided by adjusting means, which are controlled by a control device, in a near area of an antenna body, such that the extent of an overlap of the two bodies in the near area of the antenna body is changed until at least one physical input variable, which represents the reception and transmission quality, reaches an optimum.

Figure 1

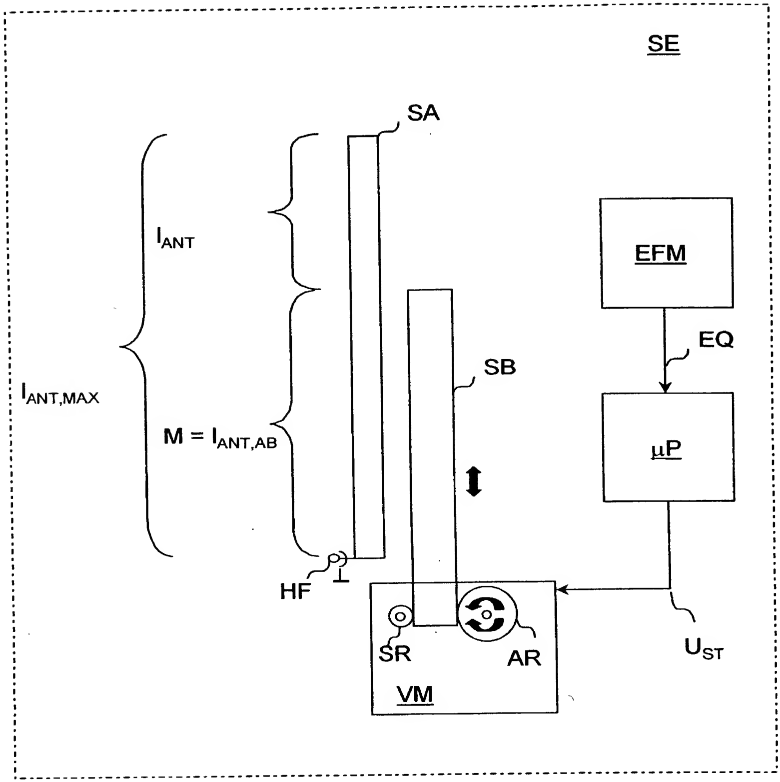

FIG 1

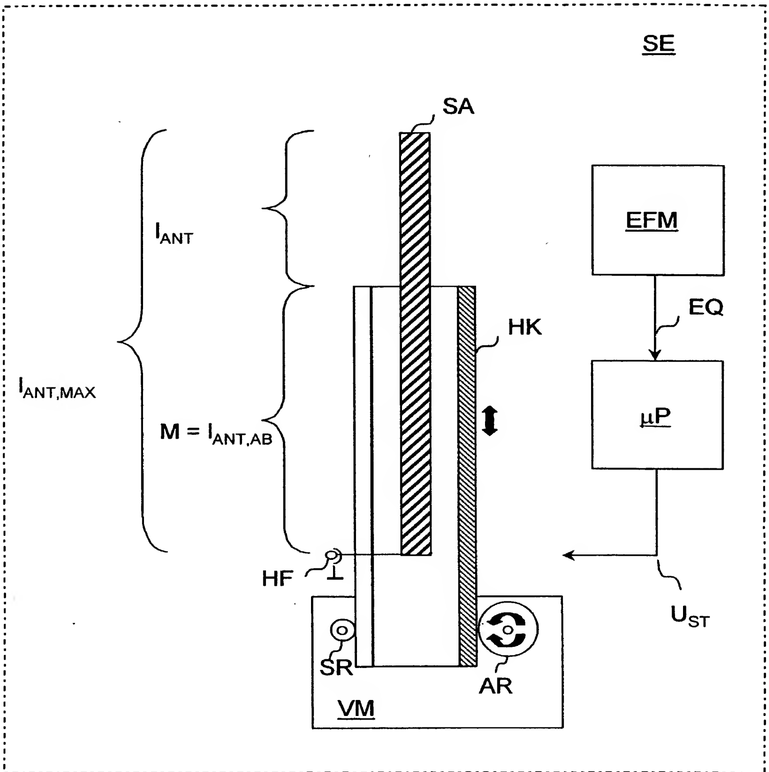

FIG 2

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel.

Mobile Funk-Sende-/Funk-Empfangseinrichtung mit abstimmbarer Antenne

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 06.09.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/03077
eingereicht wurde und am _______
abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1 56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Mobile radio transmitting/receiving device comprising a tunable antenna

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 06.09 2000 as
PCT international application
PCT Application No. PCT/DE00/03077
and was amended on __________
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Prioritat beansprucht

Priority Claimed

19943118.3 (Number) (Nummer)	DE (Country) (Land)	09.09.1999 (Day Month Year Filed) (Tag Monat Jahr eingereicht)	☒ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der fruheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/03077 (Application Serial No.) (Anmeldeseriennummer)	06.09.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	anhängig (Status) (patentiert, anhängig, aufgegeben)	pending (Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M, J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erklare hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: *(Name und Registrationsnummer anführen)*

POWER OF ATTORNEY. As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

29177

PATENT TRADEMARK OFFICE

And I hereby appoint

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1-00

Voller Name des einzigen oder ursprünglichen Erfinders:	Full name of sole or first inventor.
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Unterschrift des Erfinders / Datum: Alfred Deinert 7.2.2002	Inventor's signature / Date
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Voller Name des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any
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Unterschrift des Erfinders / Datum: Matthias Lungwitz 07-02-02	Second Inventor's signature / Date
Wohnsitz: Bocholt, DEUTSCHLAND DEX	Residence: Bocholt, GERMANY
Staatsangehörigkeit: DE	Citizenship: DE
Postanschrift: Knufstr. 25	Post Office Address: Knufstr. 25
46399 Bocholt	46399 Bocholt

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).